

FUZZY EXPERT SYSTEM FOR DECISION MAKING IN MYOCARDIAL INFARCTION

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of the requirements for the degree
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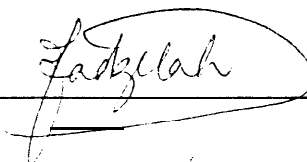
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ABSTRACT (MALA Y)

Sistem pembuatan keputusan telah diperkenalkan dalam pelbagai bidang dan pada masa kini, dunia pengkomputeran sedang memfokuskan terhadap pembangunan sistem berasaskan pengetahuan. Sistem berasaskan pengetahuan adalah salah satu cabang dalam bidang Kepintaran Buatan (AI) yang memuatkan pengetahuan manusia ke dalam sesebuah sistem untuk menguruskan proses perolehan pengetahuan. Sistem gabungan Kepintaran Buatan yang terdiri daripada beberapa teknik AI telah menunjukkan keputusan yang memberangsangkan dalam menjalankan diagnosis. Namun setakat ini hanya beberapa sistem sahaja yang menggunakan pendekatan sedemikian dalam diagnosis perubatan. Kajian ini mencadangkan teknik gabungan Kepintaran Buatan untuk digunakan dalam sistem yang dikenali sebagai FEMInS. Sistem ini menggabungkan teknologi logik kabur dan sistem pakar yang boleh membantu doktor bukan pakar untuk membuat peramalan dan diagnosis serung penyakit jantung berdasarkan tunda-tunda awal penyakit berkenaan. Oleh kerana iogik kabur boleh digunakan untuk membuat ramalan dan sistem pakar pula dapat memberikan penerangan dan penjelasan, kombinasi kedua-dua bidang ini sesuai untuk pembangunan sistem perubatan. Ini disebabkan bidang ini biasanya perlu menangani masalah ketidakpastian dan memberikan penjelasan tentang kenapa sesuatu keputusan itu dibuat kepada pesakit. Pembangunan FEMInS telah menunjukkan bahawa iogik kabur boleh menangani ketidakpastian dengan lebih baik daripada sistem pakar biasa. Ini adalah berdasarkan fakta bahawa iogik kabur menggunakan beberapa label dan nilai keyakinan untuk mencapai keputusan yang dibuat.

ABSTRACT (ENGLISH)

Decision support system has been introduced in many domains and currently, the computing world is focusing on decision support system with knowledge-based. Knowledge-based system is one of the branches in artificial intelligence (AI), which incorporates human knowledge into the system as a result of knowledge acquisition process. Hybrid AI system, which is composed of multiple AI methods, has shown quite remarkable results in diagnosis and so far only a few of such approach has been done in medical diagnosis. This study proposes the hybrid AI techniques to be used in the system known as FEMInS. This system integrates fuzzy logic technology with expert system, which helps the general medical practitioner to predict as well as diagnosing heart attack based on early symptoms. Since fuzzy logic can be used for prediction, and expert system can provide explanation and reasoning, the combination of both fields is suitable for medical domain system, which generally needs to cuter the problems **of** uncertainty and provide the explanation **of** the results to the user. FEMInS development has demonstrated that fuzzy logic can handle uncertainty better than expert system. This is due to the fact that fuzzy logic uses multi label and multi confidence value to reach the conclusion.

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CHAPTER 1

INTRODUCTION

This section briefly presents the background, problem statements, goal or objective, project significance and project scope. The main idea of the study is to combine expert system and fuzzy logic to form a hybrid intelligent system that is able to diagnose myocardial infarction cases.

1.1 Background

In most developing countries, insufficient of medical specialist has increased the rate of death of patients suffered from various diseases (McEwin, 1997). Current practice for medical treatment required patients to consult specialist for further diagnosis and treatment. Other medical practitioner may not have enough expertise or experience to deal with certain high-risk diseases. However, the waiting time for treatments normally takes a few days, weeks or even months. By the time the patients see the specialist, the disease may have already spread out to other parts of their body. As most of the high-risk disease could only be cured at the early stage, the patients may have to suffer from the disease for the rest of their life.

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REFERENCES

- Ambrosiadou V. B. (1989). Review: Diabetes: An expert system for education in Diabetes Management. *Expert System Application*, pp. 227-238.
- Aversa F., Gronda E., Pizzuti S., Aragno C. (2001). A Fuzzy Logic Approach to Decision Support in Medicine.
- Buchanan B. G, and Shortliffe E. H. (1985). Rule based Expert Systems: The MYCIN Experiments of the Stanford Heuristic Programming Project, *Addison-Wesley*.
- C.S. Herrmann. (1995). Fuzzy logic as interfacing technique in hybrid AI-systems. *Fuzzy Logic in Artificial Intelligence*, pp. 69-80.
- C. S. Herrmann. (1996). A hybrid fuzzy-neural expert system for diagnosis, In *Proc. of the Fourteenth International Joint Conf. on Artificial Intelligence*, Vol. I, pp. 494—502.
- Campbell R.H., Kirsten E.T., Michael J.C. (2000). Forecasting Emerging Market Returns Using Neural Networks, *Emerging Markets Quarterly*.
- Chung E. K. (1983). *Cardiovascular Diseases (2nd Ed)*, J. B Lippincott Company, US.
- Duda R. O., Gaschnig J., Hart P. E. (1979). Model design in the PROSPECTOR consultant system for mineral exploration.
- Durkin J. (1994). *Expert System: Design and Development*, New York: Macmillan.
- E. H. Shortliffe. (1976). *Computer- based Medical Consultations: MYCIN*. El- sevier, New York.
- Friedrich Steimann (2001). On the use and usefulness of fuzzy sets in medical {AI}, *Journal Artificial Intelligence in Medicine*, Vol. 21, no 1-3, pp 131-137.
- Martin J. (1990). The truth, the whole truth, and nothing but the truth: an indeed bibliography to the literature on truth maintenance system, *AI Magazine*.
- J.E. Moody. (1995). Economic forecasting: Challenges and neural network solutions. In *Proceedings of the International Symposium on Artificial Neural Networks*. Hsinchu, Taiwan.
- Jackson P. (1995). *Introduction to Expert System*, Addison-Wesley.
- Kulikowski C. A, Weiss S. M., (1985). *Computer System that Learns*, Morgan Kaufmann.

- Lindsay R. K., Buchanan B. G., Feigenbaum E. A., Lederberg J. (1980). *Applications of artificial intelligence for organic chemistry : the DENDRAL project*, New York: McGraw Hill.
- Linkens, D.A., Abbod, M.F., Mahfouf, M. (2000). Intelligent Systems in BioMedicine. In *Proceedings of ESIT'2000, European Symposium on Intelligent Techniques*, September 14-15, 2000, Aachen, Germany; ERUDIT (Ed.), pp. 46-61.
- National Institute of Health (NIH). (1997). Educational Strategies To Prevent Prehospital Delay in Patients at High Risk for Acute Myocardial Infarction.
- Siu C.C., Shen Q. and Milne R. (1997). A Fuzzy Expert System for Turbomachinery Diagnosis. *IEEE Int. Conf. on Fuzzy Systems*, Vol. 1, pp. 555-560.
- Smith R. G., Baker J. D. (1983). The dipmeter advisor system: a case study in commercial expert system development, In *Proc 8th IJCAI*, pp 122-129.
- Statistic from Ministry of Health Malaysia, (1996). .
- T. L. Seng, M. Bin Khalid, R. Yusof. (1999). Tuning of a neuro-fuzzy controller by genetic algorithm. *IEEE Transactions on Systems, Man and Cybernetics, Part B: Cybernetics*, 29(2):226—236.
- Tyan C. Y. and Wang P. P. (1994). Fuzzy Expert System for Airplane Navigation Dynamics.
- Wan Hussain and Fadzilah Siraj. (2002). Artificial Intelligence in Medical Application: An Exploration. Online Journal: Health Informatics Europe: BJHC Ltd. <http://www.hi-europe.info/files/2002/9980.htm>, pp. 1-9.
- Warren J., Beliakov G, Zwaag B. V. D. (2000). Fuzzy Logic in Clinical Practice Decision Support Systems. In *Proceedings of the 33rd Hawaii International Conference on System Sciences*.
- Waterman D. A. (1986). *A Guide to Expert System*, Addison-Wesley.
- Weiss S. M., Kulikowski C. A., Amarel S., Safir A. (1977). A model-based method for computer-aided medical decision making, *Artificial Intelligence*, 11(1-2): pp. 145-172.
- World Health Organization (WHO) Report (1997).